

WHAT IS CLAIMED IS:

1. A crystalline semiconductor thin film, wherein:

a carbon content and a nitrogen content are 5×10^{18} atoms/cm³ or less, and an oxygen content is 1.5×10^{19} atoms/cm³ or less;

a main orientation plane is a {110} plane;

an absolute value of a rotation angle made by equivalent axes between adjacent crystal grains or by axes in rotation relation of 70.5° with respect to the equivalent axes is within 4°;

a film thickness is 5 to 40 nm; and

the semiconductor thin film is made of single crystal or substantially single crystal.

2. A crystalline semiconductor thin film, wherein:

a carbon content and a nitrogen content are 1×10^{18} atoms/cm³ or less, and an oxygen content is 5×10^{18} atoms/cm³ or less;

a main orientation plane is a {110} plane;

an absolute value of a rotation angle made by equivalent axes between adjacent crystal grains or by axes in rotation relation of 70.5° with respect to the equivalent axes is within 4°;

a film thickness is 5 to 40 nm; and

the semiconductor thin film is made of single crystal or substantially single crystal.

3. A semiconductor device including a circuit which is constituted by a thin film transistor having a semiconductor thin film as a channel formation region, wherein the semiconductor thin film is characterized in that:

a carbon content and a nitrogen content are 5×10^{18} atoms/cm³ or less, and an oxygen content is 1.5×10^{19} atoms/cm³ or less;

a main orientation plane is a {110} plane;

an absolute value of a rotation angle made by equivalent axes between adjacent crystal grains or by axes in rotation relation of 70.5° with respect to the equivalent axes is within 4° ;

a film thickness is 5 to 40 nm; and

the semiconductor thin film is made of single crystal or substantially single crystal.

4. A semiconductor device including a circuit which is constituted by a thin film transistor having a semiconductor thin film as a channel formation region, wherein the semiconductor thin film is characterized in that:

a carbon content and a nitrogen content are 1×10^{18} atoms/cm³ or less, and an oxygen content is 5×10^{18} atoms/cm³ or less;

a main orientation plane is a {110} plane;

an absolute value of a rotation angle made by equivalent axes between adjacent crystal grains or by axes in rotation relation of 70.5° with respect to the equivalent axes is within 4° ;

individual crystal grains are in contact with each other with a rotation angle, and an absolute value of the rotation angle is within 4° ;

a film thickness is 5 to 40 nm; and

the semiconductor thin film is made of single crystal or substantially single crystal.

5. A method of fabricating a crystalline semiconductor thin film, comprising the steps of:

adding a catalytic element for facilitating crystallization of an amorphous semiconductor thin film to a part or an entire region of the amorphous semiconductor thin film;

carrying out a first heat treatment to transform the part or the entire region of the amorphous semiconductor thin film into a crystalline semiconductor thin film; and

carrying out a second heat treatment for the crystalline semiconductor thin film at 900 to 1200°C in a reducing atmosphere.

6. A method according to claim 5, wherein the second heat treatment is carried out in the reducing atmosphere in which a concentration of oxygen or an oxide compound is not higher than 10 ppm.

7. A method of fabricating a crystalline semiconductor thin film, comprising the steps of:

adding a catalytic element for facilitating crystallization of an amorphous semiconductor thin film to a part or an entire region of the amorphous semiconductor thin film;

carrying out a first heat treatment to transform the part or the entire region of the amorphous semiconductor thin film into a crystalline semiconductor thin film; and

carrying out a second heat treatment for the crystalline semiconductor thin film in a reducing atmosphere including a halogen element.

8. A method according to claim 6, wherein the second heat treatment is carried out at a temperature of 900 to 1200°C.

9. A method according to claim 7, wherein the second heat treatment is carried out in the reducing atmosphere in which a concentration of oxygen or an oxide compound is not higher than 10 ppm.

10. A method of fabricating a crystalline semiconductor thin film, comprising the steps of:

adding a catalytic element for facilitating crystallization of an amorphous semiconductor thin film to a part or an entire region of the amorphous semiconductor thin film;

carrying out a first heat treatment to transform the part or the entire region of the amorphous semiconductor thin film into a crystalline semiconductor thin film;

carrying out a second heat treatment of irradiating the crystalline semiconductor thin film with ultraviolet light or infrared light; and

carrying out a third heat treatment for the crystalline semiconductor thin film at 900 to 1200°C in a reducing atmosphere.

11. A method according to claim 10, wherein the third heat treatment is carried out in the reducing atmosphere in which a concentration of oxygen or an oxide compound is not higher than 10 ppm.

12. A method of fabricating a crystalline semiconductor thin film, comprising the steps of:

adding a catalytic element for facilitating crystallization of an amorphous semiconductor thin film to a part or an entire region of the amorphous semiconductor thin film;

carrying out a first heat treatment to transform the part or the entire region of the amorphous semiconductor thin film into a crystalline semiconductor thin film;

carrying out a second heat treatment of irradiating the crystalline semiconductor thin film with ultraviolet light or infrared light; and

carrying out a third heat treatment for the crystalline semiconductor thin film in a reducing atmosphere including a halogen element.

13. A method according to claim 12, wherein the third heat treatment is carried out at a temperature of 900 to 1200°C.

14. A method according to claim 12, wherein the third heat treatment is carried out in the reducing atmosphere in which a concentration of oxygen or an oxide compound is not higher than 10 ppm.

15. A method of fabricating a semiconductor device including a thin film transistor, wherein the thin film transistor is formed through the steps of:

adding a catalytic element for facilitating crystallization of an amorphous semiconductor thin film to a part or an entire region of the amorphous semiconductor thin film;

carrying out a first heat treatment to transform the part or the entire region of the amorphous semiconductor thin film

Sub C1
into a crystalline semiconductor thin film; and

carrying out a second heat treatment for the crystalline semiconductor thin film at 900 to 1200°C in a reducing atmosphere.

Sub C1
16. A method according to claims 15, wherein the second heat treatment is carried out in the reducing atmosphere in which a concentration of oxygen or an oxide compound is not higher than 10 ppm.

17. A method of fabricating a semiconductor device including a thin film transistor, wherein the thin film transistor is formed through the steps of:

Sub C2
adding a catalytic element for facilitating crystallization of an amorphous semiconductor thin film to a part or an entire region of the amorphous semiconductor thin film;

carrying out a first heat treatment to transform the part or the entire region of the amorphous semiconductor thin film into a crystalline semiconductor thin film; and

carrying out a second heat treatment for the crystalline semiconductor thin film in a reducing atmosphere including a halogen element.

Sub C1
18. A method according to claim 17, wherein the second heat treatment is carried out at a temperature of 900 to 1200°C.

19. A method according to claims 17, wherein the second heat treatment is carried out in the reducing atmosphere in which a concentration of oxygen or an oxide compound is not higher than 10 ppm.

20. A method of fabricating a semiconductor device including a thin film transistor, wherein the thin film transistor is formed through the steps of:

adding a catalytic element for facilitating crystallization of an amorphous semiconductor thin film to a part or an entire region of the amorphous semiconductor thin film;

carrying out a first heat treatment to transform the part or the entire region of the amorphous semiconductor thin film into a crystalline semiconductor thin film;

carrying out a second heat treatment of irradiating the crystalline semiconductor thin film with ultraviolet light or infrared light; and

carrying out a third heat treatment for the crystalline semiconductor thin film at 900 to 1200°C in a reducing atmosphere.

21. A method according to claim 20, wherein the third heat treatment is carried out in the reducing atmosphere in which a concentration of oxygen or an oxide compound is not higher than 10 ppm.

22. A method of fabricating a semiconductor device including a thin film transistor, wherein the thin film transistor is formed through the steps of:

adding a catalytic element for facilitating crystallization of an amorphous semiconductor thin film to a part or an entire region of the amorphous semiconductor thin film;

carrying out a first heat treatment to transform the part

or the entire region of the amorphous semiconductor thin film into a crystalline semiconductor thin film;

carrying out a second heat treatment of irradiating the crystalline semiconductor thin film with ultraviolet light or infrared light; and

carrying out a third heat treatment for the crystalline semiconductor thin film in a reducing atmosphere including a halogen element.

23. A method according to claim 22, wherein the third heat treatment is carried out at a temperature of 900 to 1200°C.

24. A method according to claim 22, wherein the third heat treatment is carried out in the reducing atmosphere in which a concentration of oxygen or an oxide compound is not higher than 10 ppm.